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CAWTHRON INSTITUTE,

NELSON, NEW ZEALAND.

Some Personal Memories of Lord Rutherford of Nelson

BY

SIR HENRY DALE, O.M., G.B.E., F.R.S. etc.

NELSON.
R. W. STILES & CO. LTD., PRINTERS,

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Foreword

While on a visit to New Zealand at the invitation of the N.Z. Government in 1949, Sir Henry Dale, noted scientist of Great Britain, gave several lectures of great interest and value to science in New Zealand. In both Christchurch and Nelson, he very kindly consented to give public lectures on "Some Personal Memories of Lord Rutherford of Nelson."

At Christchurch the lecture was held under the auspices of Rutherford's old College, Canterbury University College, and at Nelson under the auspices of the Cawthron Institute and the Nelson Philosophical Society.

In view of Lord Rutherford's association as a boy with primary schools in the Nelson district and with Nelson College and as a student with Canterbury University College, the governing bodies of both the Cawthron Institute and of Canterbury University College regard it as a privilege and honour to publish conjointly Sir Henry Dale's lecture on Lord Rutherford.

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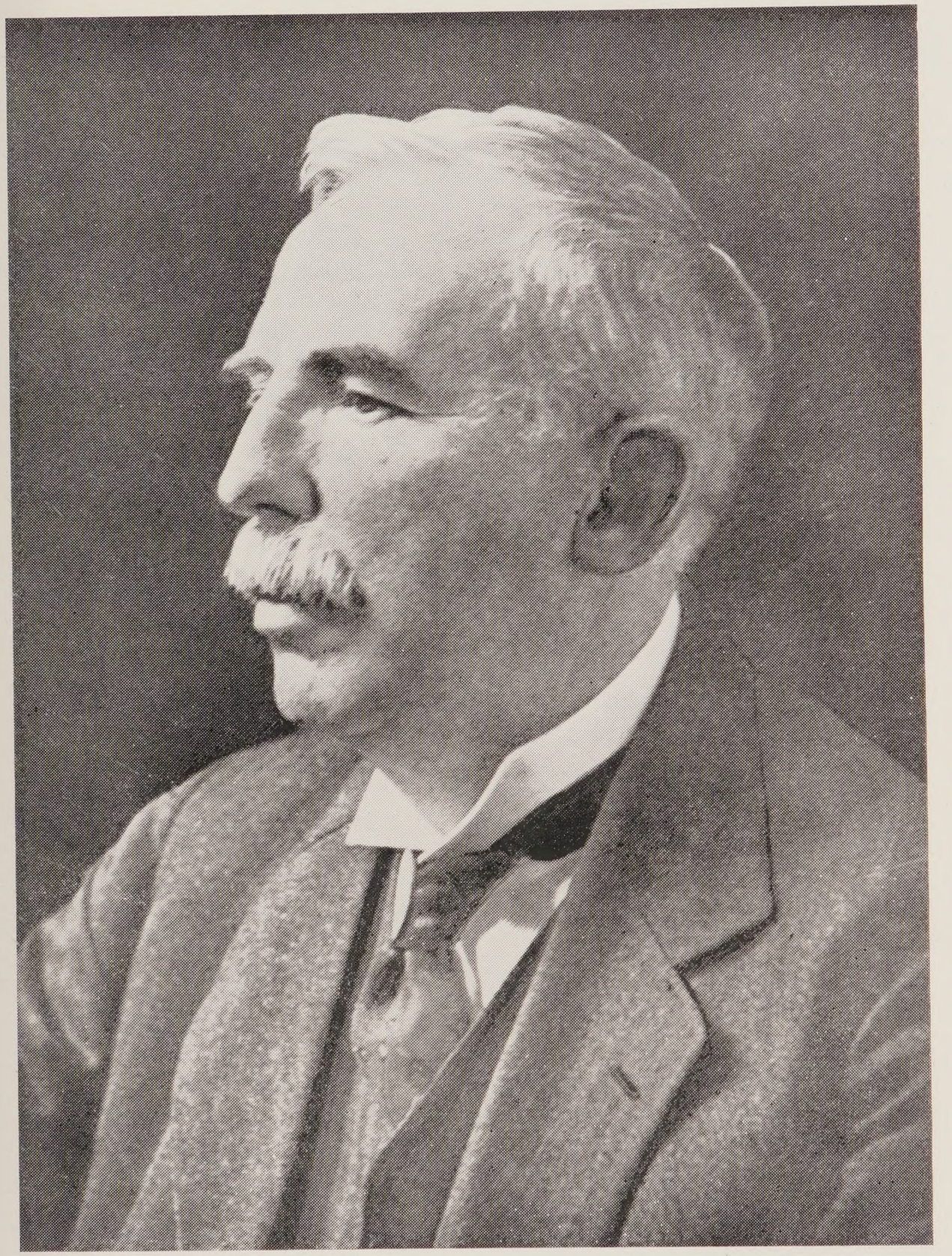

Rutherford

Ernest Rutherford was born in 1871 at Spring Grove, near Brightwater, 13 miles out of Nelson. A photograph of the little wooden cottage has been preserved, and is reproduced in the late Professsor Eve's biography of Rutherford; but the house itself has disappeared. There appears to be some local rivalry, indeed, of claims to have been the place of Rutherford's birth, between Spring Grove and Brightwater as they are to-day. The most likely account of the matter suggests that the Rutherford home, though belonging to Spring Grove as defined when he was born there, was later incorporated into Brightwater township, so that each of the still contiguous territories has some basis of claim.

Ernest was one of eleven Rutherford children. His father, James Rutherford, son of an early settler, seems to have been primarily a wheelwright by trade, but to have combined this with small farming. With one of several brothers settled in the same neighbourhood, James Rutherford seems also to have been engaged in logging and making sleepers for the railway then being built, and in flax-milling when the railway construction was suspended. These varieties of occupation, together, presumably, with the claims of a rapidly growing family for accommodation, entailed several removals, with consequent changes of school for the children.

It is proper that the world should remember Ernest Rutherford as a son of New Zealand, and of its South Island in particular; for though his discoveries belong to mankind, and though the opportunities to make them came to him almost entirely in other parts of the British Empire, the conditions of his childhood, youth and early manhood here must have had a strong influence on the development of his great natural endowments. He would surely, indeed, have shown greatness of ability and character in some direction, if he had been born in Dundee, from which his father's father, or in Hornchurch in Essex, from which his mother's mother came to New Zealand, both as relatively early immigrants and settlers. It was after the early death in Hornchurch of her husband, who is rumoured to have been a man of remarkable ability, that the maternal grandmother had come to New Zealand with her young daughter; and some have been disposed to trace a major share of Ernest Rutherford's inheritance of ability to this English grandfather whom he never knew. However that may be, I think that we may safely assume that the same fortunate combination of parental genes must anywhere have produced the essential Rutherford. But the conditions

RUTHERFORD HOME AT FOXHILL, NELSON DISTRICT, N.Z., ABOUT 1880.

NELSON COLLEGE, NELSON, N.Z., WHERE RUTHERFORD RECEIVED HIS SECONDARY SCHOOL EDUCATION 1886-1888.

of the new country into which he was born, in which he spent his childhood and to which his thoughts always went back as his home—the daily contacts with individual craftsmanship and husbandry, the constant demands for contrivance, opportunism and independent enterprise, the freedom of the open country and the bracing encounters with physical hardship, danger and even tragedy, as when it fell to him to take the news to his mother that two of his younger brothers had been drowned in a boating accident in the Pelorus Sound—all these must surely have added strong fibres to the texture of the boy Rutherford's experience, and favoured the sound and firm ripening of his great natural gifts of ability and character.

To these steady influences exercised by his parents and home surroundings, there was to be added, from quite early years, the more formal stimulus of excellent schooling. Ernest Rutherford's father would have inherited a traditional Scottish faith in the value of education, and his mother had herself been a school teacher before her marriage. "I should never have been where I am to-day if it hadn't been for my mother and father," said Rutherford in after years, referring to the personal sacrifices which he knew that his parents must have made, in order to ensure for him the education which his talents merited. From the first he was very fortunate, too, in his teachers. With other members of the family, it appears that he had his first childish schooling at Spring Grove, where his mother had taught before her marriage, in succession to her own mother. The father soon moved with his family, however, to Foxhill, some ten miles further south, and it is at the primary school there that we can identify Ernest Rutherford's first able teacher in Mr. Henry Ladley, who had charge of his education between the ages of $5\frac{1}{2}$ and 11 years. The family then made a further move to Havelock, on Pelorus Sound, and at the school there young Rutherford had such stimulating teaching from Mr. J. H. Reynolds that, four years later, at the age of fifteen, he won a scholarship to Nelson College, with an astonishing total of 580 out of a possible 600 marks in all his papers. At Nelson College again he was fortunate in the two headmasters of his time, Mr. Ford and Dr. Littlejohn, who seems to have transmitted respectively much that was best in English and Scottish scholastic traditions. Dr. Littlejohn's system was centred on the classics but extended to a wide range of other disciplines, and especially to a sound training in mathematics. Mr. C. H. Broad, who was Ernest Rutherford's contemporary at Nelson College, and who

himself later succeeded to the headmastership, tells me that chemistry came to Rutherford as a new subject when he entered the sixth form, and required hard work from him to overtake the others. By 1888, however, when he was 17, he was top of the sixth form in all subjects, and was reported by the master to show special promise in mathematics.

We learn from one of his schoolfellows that Rutherford used later to say that, if he had not won the scholarship to Nelson he would probably have been a farmer. It is tempting, indeed, to speculate as to what might then have happened. The bearer of the greatest name in natural science, at a much earlier stage of its development in Britain, Isaac Newton, did actually leave the school at Grantham, in Lincolnshire, when he was 16, in order to take charge of the family farm for his widowed mother. Newton, however, was so often a truant from his farming to indulge his passion for mathematics, that his mother most fortunately sent him back to school, and thence in due course to Trinity College Cambridge—whither, more than two centuries later, Ernest Rutherford was to follow him. Rutherford seems to have shared with Newton a schoolboy faculty for making mechanical models. On the other hand, he never showed any of that aloofness and self-absorption, which were to make Newton an almost morbid recluse during so large a part of his Cambridge period. As a boy, Rutherford showed, indeed, no kind of freakish precocity; he had a robust and normal enjoyment of life, of play as well as work, and he excelled in studies over so wide a range that, even at the end of his period at Nelson, his interests had not yet found a particular focus. If chance, then, as he himself thought possible, had earlier made Rutherford a farmer, I believe he would have been a very good one. There was a beginning, when he was young, of a very progressive application of science to agriculture, and this might well have fired his imagination. In one direction or another, we may be sure that Rutherford could have done good service to farming and agricultural science in New Zealand; but even New Zealand, I think, was better served, in the long run, by the career into which the further course of his education led him. For it gave, not merely scope, but wings to his soaring genius, and made him a benefactor of mankind at large, as leader of that tremendous advance in the physical sciences which, in the course of a few decades, was to transform for all of us the very way in which we think of the ultimate nature of the material universe.

After his all-round successes at Nelson College it was natural for Ernest Rutherford to win a Junior Scholarship to the University of New Zealand; with this he matriculated in 1889, to enter Canterbury College, Christchurch, at the normal age of 18. By 1892, when he was 21, he had graduated B.A and had won a Senior University Scholarship in Mathematics, which at that stage was still regarded as his strongest line. After another year of mathematics under Professor Cook and, in addition, of Chemistry and Physics under Professor Bickerton, Rutherford graduated M.A. with the unusual distinction of double first-class honours, both in Mathematics and Physical Science. And then came a crucial fifth year, in which he continued to work at Canterbury College, for a higher research degree in natural science. Then it was that he began his first experimental researches, working, it would appear, largely on his own initiative, and feeling the first thrill of success as an original discoverer.

These first experiments at Canterbury are noteworthy, indeed, not only for the bright promise which they gave of Rutherford's later supremacy among experimenters, but also as providing, in essence, the methods and ideas for his first research at Cambridge, which was, in fact, an extension of them. When he thus began to try his hand at research at Canterbury College, the experimental demonstration by Hertz, of the possibility of producing the invisible, electromagnetic waves which Maxwell had foreseen in theory, and which we now call "wireless waves," was still an exciting novelty. Young Rutherford set up a Hertz oscillator in a cellar at Canterbury College, which he was allowed to use for the purpose, actuating the instrument with an induction coil, or with an electrical machine of a type then in use. A brass tablet in the outside wall of this "den" now marks the place of this historic event. He found that the alternating current impulses, which he thus generated and transmitted as waves across the room to a receiver, if they were made to pass through a little coil of fine wire, would magnetise steel needles or iron wires inserted into the coil, or change the strength of their magnetization if they were magnets already; and thus the little coil with its core was made to change its position, if it had been suspended in a magnetic field. He investigated this phenomenon very completely, and later published a description of his findings, which had involved him in the measurement of time intervals as short as the 100,000th part of a second—a really remarkable technical achievement for a beginner, in those pre-electronic days. He seems to have recognised early the

practical possibilities of his little bundle of magnetized needles, with its surrounding coil of insulated wire, as a detector of the Hertzian waves, and to have made with it a contrivance which enabled him, while still at Canterbury College, to record a wireless signal transmitted the whole length of the physical laboratory, the lower storey of the "tin shed' 'of those days, and through several intervening walls—about 60 feet in all; and since he achieved this in 1894 or 1895, he must, at that point, have been some years in advance of the similar observations by Marconi, which were to have such tremendous practical developments.

Rutherford at 23, however, had reached no premature climax of ability, or of mental enterprise such as Isaac Newton seems to have attained at that age. To a fellow student at Canterbury College he seemed to be just "a boyish, frank, simple and very likeable youth, with no precocious genius; but," his friend continued, "when once he saw his goal he went straight for the central point"; and that early personal estimate also contains something prophetic of the man he was to become.

Probably the most important effect of this first research work at Canterbury College was that it opened for Rutherford the possibility of going to Cambridge, to work there under J. J. Thomson. The Commissioners administering a fund which had been derived from the profits of the first great International Exhibition, held in London in 1851, had created Overseas Scholarships, to enable young science graduates from Dominion universities to continue their researches and make wider contacts, in British universities and other appropriate centres. The candidates were to be put forward by their own universities, and 1895 was the year of New Zealand's opportunity. Rutherford was one of the two presented by the University of New Zealand, and, after an initial uncertainty, he became its first Overseas Scholar. He borrowed the money to pay his passage to England, and set out in September, 1895, for London and Cambridge. Many years later, when he had become the world's acknowledged leader in the new physics, and was President of the Royal Society of London, Rutherford himself became one of the Commissioners administering the 1851 Exhibition Fund. Some alternative claim on the income had led members of the Board to raise the question whether the Overseas Scholarships were still serving their purpose. This roused Rutherford to a characteristic intervention, as free from anything like mock-modesty as

THE "DEN," CANTERBURY UNIVERSITY COLLEGE, CHRISTCHURCH, N.Z., WHERE RUTHERFORD COMMENCED HIS FIRST EXPERIMENTAL RESEARCH ON WIRELESS WAVES IN 1894.

THE "DEN," SHOWING COMMEMORATIVE BRASS PLATE.

THE "DEN," INSIDE VIEW, 1950.

it was from any hint of pretentiousness. "You might remember," said he, "that if there hadn't been any Overseas Scholarships you wouldn't have had any Rutherford here!" And the Overseas Scholarships are still being awarded.

Rutherford had arrived in Cambridge in 1895, as one of the first batch of post-gratudate research students admitted there from other universities; and, on J. J. Thomson's recommendation, he entered himself as a student of Trinity College at the beginning of the October term of that year. "He wished me to join Trinity," he wrote home at the time, "which is his own college and also the best as well as the dearest in the university." One can imagine that this question of cost, to one dependent upon the slender support of the Scholarship, may well have been a matter of more immediate concern, even than the imposing traditions of a College where Isaac Newton, Clerk Maxwell and Lord Rayleigh had been students and fellows before him, as well as "J.J." himself. I was then an under-graduate scholar of Trinity, begininng my second year. The new post-graduate research students, of whom the College had accepted a number, dined in the Hall at the bachelors' table, so that I did not begin to meet Rutherford regularly there till nearly two years later. We ordinary Cambridge students, like not a few of our seniors, were inclined at first to look a little askance at these representatives of a new species, older than ourselves by several years, and neither just undergraduates, nor proper dons, as we might have said. We soon found, however, that most of them fitted into the picture remarkably well. Rutherford was probably the most brilliant of them all, though we might not have recognised him as such for ourselves. He was open and friendly in his manner, simple and direct in his judgment of matters on which he thought himself entitled to an opinion; but he was free from any trace of those airs of portentous wisdom, of effortless brilliance, or artificial enthusiasm, which a clever undergraduate from the English schools was often tempted to assume, and which his contemporaries were too ready to accept at their face value. If we had been inclined to look critically at Rutherford, I think that we young cynics might have described his manner as rather hearty, and even a little boisterous; but I can imagine us allowing, with pride in our tolerance, that a man who had been reared on a farm, somewhere on the outer fringes of the British Empire, might naturally be like that, and might nevertheless have the remarkable ability which rumour was beginning to attribute to him.

I had new opportunities of contact with Rutherford soon after May 2nd, 1896, when he was elected a member of the Cambridge University Natural Science Club—a small and intimate body of some twelve members, undergraduates and younger graduates who were supposed to have shown some special promise or line of interest in science. I became a member at the meeting after that at which Rutherford was elected. The meetings were held in the rooms of the members in rotation, on Saturday evenings; and the member thus entertaining the Club was expected to provide coffee and some light refreshment with it—sardines on toast formed the standard provision in those days—and then to read a paper, or make a communication, on some matter of current scientific interest, usually, of course, in the range of his own special studies or knowledge. Naturally the post-graduate research students who joined the Club were expected to have something special to say about their own researches, since they had the advantage of being already engaged in researches, about which we juniors were only hearing or reading; and I have a very vivid memory of a meeting held in Rutherford's lodgings in Park Street—then a row of houses looking out over Jesus Common to the not distant River Cam. From his letters home to his mother, and to Mary Newton of Christchurch, who was to become his wife, it is clear that, on arriving at Cambridge in the autumn of 1895, he must have settled down to repeat and extend his Canterbury College experiments on the detection of the Hertzian waves at a distance. We know that he had brought his little electro-magnetic detector with him from New Zealand, and had taken the opportunity, made by a call of his ship at Adelaide, to demonstrate it to W. H. Bragg, who was then Professor of Physics there. He writes from Cambridge on December the 8th, 1895, that he "can get quite a large effect at twenty yards"; but from other evidence we know that he had already achieved that before he left Christchurch. On February 21st, 1896, however, there is a long description of an attempt to obtain transmission through about half a mile across the Common, which failed, because, as he discovered with relief, his detector had broken down at the critical moment. And then, on February 29th, he is able to record that, on the day after this failure, he had succeeded in detecting waves from the Cavendish Laboratory to Townsend's lodgings, more than half a mile away, and "through solid stone houses all the way." It was not till July of that year, however, that he began to tell the Natural Science Club about these experiments. Like other students *'in statu pupillari'* he had at that date

moved into College, as temporary occupant of an absent student's rooms, during the Long Vacation; and on July 25th Rutherford entertained the Club in the College rooms which he was thus occupying, and read a paper on "A New Method of Detecting Electric Oscillations." The Club minutes show that, as might be expected, what Rutherford described was "his method of detecting oscillations by means of the effect they produce on magnets," and that "the paper was illustrated by showing some apparatus used in his experiments." On this occasion, then, he only showed the Club his detector, without demonstrating its action. The next Club meeting for which Rutherford was responsible was on May 15, 1897, and is recorded as held in his lodgings at 49 Park Street. The title given for the paper in the Club's record is "Invisible Radiation." There is no minute giving the gist of it, but I am sure that it must have dealt with wireless waves to which the title would quite well have applied at that time. For this is the only meeting on record as held at Rutherford's rooms in Park Street, and I remember very clearly his demonstrating there the possibility of detecting Hertzian waves originating in the Cavendish Laboratory, half a mile away.

As my memory pictures the scene, he had the receiving apparatus on the table of his living-room, and he had contrived that the effect of the waves on his electromagnetic detector should somehow start the ringing of an electric bell. He explained to us he had arranged with somebody in the Cavendish Laboratory to start the Hertz oscillator there at exactly 9 p.m. by the Laboratory clock, by which he had carefully set his watch; and we all sat round the table waiting for the great moment, like a racing-boat's crew counting the seconds to the starting gun. Exactly at 9 o'clock the bell began to ring, and we greeted the demonstration with cheers; and then Rutherford gave us a short talk on the nature of the transmission which we had been witnessing. I wonder whether any of us had any sort of premonition of what might be the future of this wireless communication at a distance, of which we had been given so early a demonstration. Many years afterwards, when we used to meet often at the Royal Society, I remember Rutherford recalling this early work on wireless waves, and pondering for a minute on the possibility that he might have continued in that line of interest, instead of being diverted from it by the remarkable new discoveries of X-rays and natural radio-activity. For the news of these came in the autumn of 1895 and in the immediately following years, and was soon exciting the interest of even a wider world than that of the physicists;

and Rutherford was easily attracted thereby into researches of a more fundamental type, and with less easily marketable possibilities. He never showed, in fact, any interest in, or any instinct for, making money by inventions.

This meeting and demonstration in Rutherford's student rooms were remembered, when he and I were guests, more than 30 years later, at a dinner celebrating the completion by the Cambridge Natural Science Club of some number of hundreds of its meetings. He was then the President, and I was one of the Secretaries, of the Royal Society; and speaking after dinner in the vein appropriate to such an occasion, I recalled the meeting in Park Street, and made the scandalous suggestion that Rutherford probably had a bell-push under the carpet, to press with his foot when the bell was due to ring; to which he, in rollicking mood, replied: "I have little doubt that my friend Dale's unworthy suspicions were fully justified".

Almost up to the year of Rutherford's arrival at Cambridge, physics had appeared to be a body of admirably exact, but almost completed knowledge. Years later J. J. Thomson recalled "the pessimistic feeling, not uncommon at that time, that all the interesting things had been discovered, and all that was left was to alter a decimal or so in some physical constant". In 1894, the year before Rutherford left New Zealand, Lord Salisbury, addressing the British Association at Oxford, had reminded his hearers that, in spite of the attractive speculation that the atom of every element might be "only a great or smaller number of hydrogen atoms compacted by some strange machinery into one . . . . . the reply of the laboratories has always been clear and certain, that there is not in the facts the faintest foundation for such a theory". And, further, that "what the atom of each element is, whether it is movement, or a thing, or a vortex, or a point having inertia . . . . . these questions remain surrounded by a darkness as profound as ever". When physics or chemistry, then, came down to fundamentals, while both could claim to be making some advance in precision of measurement and in refinement of their methods of observation, both seemed at that time to be laboriously approaching a limit, beyond which science could not hope ever to penetrate to any new certainty, either by observation or by theory. And then, all at once, a new and rapidly accelerating movement began, piercing this boundary wall of finality and advancing again into a still widening vista of new knowledge. And it may be counted as one of the

NATURAL SCIENCE CLUB, CAMBRIDGE UNIVERSITY, 1898.

ROWS (LEFT TO RIGHT IN EACH CASE).

TOP: ERNEST RUTHERFORD, J. W. C. KIRK, H. H. W. PEARSON, G. S. PHILLPOTTS.

SECOND: W. M. FLETCHER, J. TALBOT, J. R. ECCLES, A. W. HILL, F. GAYNER, W. H. MILLS, R. C. PUNNETT.

THIRD: J. G. KERR, C. F. HADFIELD, F. P. BEDFORD, H. H. DALE, J. S. BUDGETT, HON. N. C. ROTHSCHILD, HON. R. J. STRUTT (LATER THE 4TH LORD RAYLEIGH).

FRONT: E. B. H. WADE, H. W. ATKINSON, L. DONCASTER.

significant coincidences of scientific history, that this new epoch in man's understanding of physical reality began only a month or two after Ernest Rutherford's arrival at Cambridge, when Röntgen discovered the X-rays. I well remember the news of that event reaching Cambridge, at first through reports in the daily papers, which emphasized, of course, the vision of opaque bones through transparent flesh. "What nonsense will they publish next"? said a lady at a Cambridge dinner party a few days later; and the chorus of frivolous incredulity was only hushed, when the well known and authoritative bark of J. J. Thomson, who was one of the guests, cut across it. "But why should it be nonsense"? said he. "It seems to me the kind of thing that is likely to be true". I remember a meeting of the Natural Science Club in the rooms of the late Sir Joseph Barcroft, on February 29th, 1896, at which a Crookes's tube, borrowed from the Cavendish Laboratory, was used to photograph the shadow of Barcroft's door-key through an ordinary, wooden dark slide. That was before Rutherford's election, and I do not remember his being present; I suppose that somebody must have taken me as a guest. And then, some years later, I remember that the Club met in the rooms of my Trinity contemporary, the Hon. R. J. Strutt, who was later to succeed his great father as Lord Rayleigh. Strutt entertained us with an account of the rays given off constantly by a salt of uranium, even if it was kept always in the dark, which M. Bacquerel had detected by their action, like the X-rays, on a photographic plate. I remember the late Sir James Jeans, who must have been a guest for that meeting, protesting that, if this were true, it would involve an infraction of the law of the conservation of energy; and I remember Strutt's reply:—"the facts", said he, "seemed to be beyond doubt; M. Bacquerel was an observer of undoubted competence and integrity; and it was so much the worse for the law of the conservation of energy". This, remember, was many years before the conversion of matter into energy began to be a seriously considered possibility. This must, I think, have been after Rutherford left Cambridge for Montreal; for, if he had been present, I am sure that my memory would have retained some characteristically vigorous and penetrating comment by him. These discussions of the Röntgen rays and of the Becquerel radiations from uranium, by the Natural Science Club in Cambridge, seem, therefore, to have taken place, the one before and the other after the few years in which Rutherford was an ordinary member; and I mention them only to recall the wave of excitement which was sweeping over the world of science in those days, when the first breach had just been made,

and was being so rapidly widened, through what had seemed to be the unpassable boundary of the classical, molar physics.

Even before he gave us the demonstration of wireless waves at long range, Rutherford had already begun to work with J. J. Thomson on the X-rays, and especially on the ionization of a gas which they produce as they pass through it. Rutherford had passed the air, containing the ions which the X-rays had produced, between parallel plates bearing positive and negative electric charges, and had shown that the ions were attracted to the oppositely charged plates and gave up their charges to them. "Ions are jolly little beggars; you can almost see them", he said long afterwards to Dr. Eve at Montreal. But while he was still at Cambridge, there are records showing that Rutherford had also begun to work already on the spontaneous radiation from uranium, that he had recognized two components in it of different penetrating powers, and that he had provisionally named these, even then, the alpha- and beta-rays; so that he had made a real beginning there of what was to be the great work of his life. As early as October 1896 at the age of 25, he is writing from Cambridge to Mary Newton: "Don't be surprised if you see a cable some morning that yours truly has discovered half-a-dozen new elements, for such is the direction my work is taking." Little wonder that he was soon beginning to be known among physicists, in Cambridge and beyond it, as a young man of very uncommon potentialities. We find him in the same year giving a lecture-demonstration to the British Association, at its annual meeting in September 1896. Remember, too, as further evidence of the rapid enlargement of the physical horizon then in progress, that 1897 was to witness J. J. Thomson's first announcement of a sub-atomic particle, the electron, in a lecture at the Royal Institution in London.

The last event to be mentioned in Rutherford's early period at Cambridge was one of some concern to me personally, namely, his election to the Coutts Trotter Research Studentship at Trinity College, late in 1897. This was the only research emolument of its kind then available, to a Trinity student of science who had not yet become eligible for a College Fellowship and the Trust Deed required its award for research in physics or physiology. To tell the truth, I had begun to keep my eye on it, with a view to a possible application in the following year, when I should have taken my final University examination. If Rutherford, then, were to hold the Studentship for the full two years, it was clear that it would not be available at the

time when I had hoped to try my luck; and I remember feeling a little forlorn about it, and wondering whether we ordinary fourth-year students would ever have a chance again, in competition for such opportunities with this constellation of brilliant graduate seniors, which the fame of J. J. Thomson and Trinity was now assembling in the College from all corners of the Empire. Nobody, however, could criticize the award to a man of Rutherford's outstanding distinction, or begrudge anything to one of his genial and straighforward character.

Rutherford resigned the Coutts-Trotter Studentship in the summer of 1898, so that, after all, it was vacant when I wanted it. The College faced, I suppose, with the difficulty of choice between a physicist and a physiologist, divided it between Strutt and myself, finding some other expedient to make up its value to both of us; and we were both very proud thus to divide the succession to Rutherford in this studentship between us. The reason for his resignation was his appointment, at the age of 27, to the Chair of Experimental Physics at the McGill University, Montreal, in succession to an already world-famous physicist and experimental engineer, Professor Callendar. It is recorded that when, later, Professor Bovey, of Montreal, remarked to J. J. Thomson that they had all been very sorry to lose Callendar from McGill, he was rather startled to receive the blunt reply: "I don't know why you should be; you got a better man anyway".

And there, for a longish period, I must interrupt my personal memories of Rutherford. He was at Montreal for 9 years, from 1898 to 1907; and what wonderful years they were for him and for physical science! The wisdom of Rutherford's moving, at that juncture, to Montreal might to some have been a matter of doubt. For Cambridge had already become one of the world's chief centres of the new movement in physics, while in Montreal there might be relative isolation; and a young man, who had still to make himself known in the wider scientific circles of the world, might be expected to find it difficult to go forward on his own unsupported initiative. Any forecast of that kind, however, would have been very wide of the mark where Rutherford was concerned. So far from lacking confidence and initiative for independent research on this new order of phenomena, Rutherford, within a year or two, was making Montreal the centre to which the whole world was turning with an almost incredulous expectation;

he was showing already a penetrating vision, an experimental resourcefulness and an intellectual courage, which soon made him the recognized leader into the new world of atomic and sub-atomic physics.

Everybody with closer interests in scientific happenings knew of Rutherford's work for nine years at Montreal, partly in conjunction with Soddy, in which so much was achieved towards revealing the nature of the intricate phenomena of atomic breakdown as the cause of natural radioactivity, and the bearing of these on the chemistry of the naturally radioactive elements. It was this work which brought him the Nobel Prize for Chemistry in 1908. And then, in his twelve years at Manchester, came his discovery of the central, small, but massive nucleus of the atom, and his co-operation with his brilliant Danish pupil, Niels Bohr, which produced the plan of the atom with its nucleus and planetary electrons. And just before he left Manchester he had made, with the simplest apparatus, experiments showing the possibility of causing an artificial disintegration of atoms of nitrogen. But during these great years I met Rutherford but seldom, and never on a footing to impress the meeting on my memory. There are, however, detailed reminiscences of Rutherford in his Montreal and Manchester periods on record, by men who had the privilege not only of close personal friendship with him in those years, but of the greater intimacy which comes of scientific collaboration. The late Professor Eve, to whom we owe the standard biography, was Rutherford's intimate colleague at Montreal, while Dr. Marsden, before he became Secretary of your Department of Industrial and Scientific Research in New Zealand, had been Rutherford's trusted assistant at Manchester. Dr. Marsden has given a vivid account of his great leader in those years, in his recent "Rutherford Memorial Lecture" to the Physical Society of London.

The first occasion of my meeting Rutherford again, of which I have a clear memory, must have been in 1920, soon after he had succeeded J. J. Thomson as Cavendish Professor. Some business had taken me to Cambridge and, using an "old boy's" privilege to dine in Trinity College, I encountered Rutherford in the Fellows' Combination Room. I wondered a little how much he might have changed, in the 22 years of his development from a research student into a world scientist of great and growing fame. Talk turned, almost inevitably, on what had become a prominent item of news in the press of the world —the confirmation of Einstein's general theory of relativity, by observations made during an eclipse, and before

the first World War had come to an end. "Well", said Rutherford, "I don't believe there are more than about six people in the whole world who really understand what that Einstein theory means". And, when I meekly enquired who might be the other five, he looked at me quizzically for a moment, and then, with a gust af laughter —"Good lord! Dale", he exclaimed, "you don't suppose that I understand it do you"? Without doubt it was the same old Rutherford. Sir James Jeans used to warn me not to take Rutherford too seriously when he disclaimed understanding of mathematical conceptions. Rutherford, he said, was a much better mathematician than he chose to admit. We all knew, however, that he did not, in fact, take interest in mathematical theories for their own sake, but only in so far as they opened up new opportunities of experiment to verify them. I well remember him after a dinner at the Royal Society's dining club—he was apt on these occasions to be even freer than at other times from hampering inhibitions—giving his views on the conceptions of the universe as a whole, put forward by rival mathematicians. "We have had four different theories about it in the last ten years", he exclaimed; "and what do you suppose will be left of any of them in another twenty? What we want is more experimental facts, and by gad, you fellows, I'm going to try to get them"! And, indeed, he and the wonderful team which had gathered round him in the Cavendish Laboratory were getting them at a tremendous pace. R. H. Fowler, who became his son-in-law and was close to him in intimate confidence, tells us that Rutherford was highly excited and delighted by the laboratory's triumphs, as well he might have been. At Montreal he had untangled the mysterious phenomena of natural radio-activity, at Manchester he had discovered the atomic nucleus and provided the basis for the plan of atomic structure, and now, at Cambridge, he was able to see rapid progress in the artificial disintegration and transmutation of elements—the "Newer Alchemy", as he called it in his last book.

I had the good fortune to see more of him than ever before when he was President of the Royal Society, from 1925 to 1930, as I was one of the Secretaries. Not long after that period came what R. H. Fowler described as the *annus mirabilis* of atomic physics, 1932, when Chadwick was led by his work with Rutherford to discover the neutron, Andersen in Pasadena discovered the 'positron', and was early confirmed in that discovery by Blackett at Cambridge, and Cockcroft and Walton first demonstrated the artificial disintegration of the atomic nuclei of a light

metal (lithium), when it was bombarded with greatly accelerated protons. I well remember Rutherford's opening speech at a discussion meeting of the Royal Society at about that time, in which he made what was probably a first general announcement of Cockcroft and Walton's highly important results. Looking round the room he said: "Cockcroft and Walton must be here somewhere. Stand up, you boys, and let them see what you look like"! The informality, which abated nothing of dignity when dignity was needed, and the friendly impulse to ensure that young men, though working under his inspiration, should get the full credit for what their skill and ingenuity had achieved, were alike characteristic of Rutherford. Working and leading in a field in which knowledge was progressing at breath-taking speed, into which other workers in different countries soon began to press eagerly, so that there were ever-present possibilities of overlap or forestalment, Rutherford never, to my knowledge, engaged in any dispute or asserted any claims to credit or priority, even with regard to lines of research and discovery where friends, on his behalf, were inclined to resent and to resist what they regarded as encroachment by others. He seemed always too big to be bothered by, or even interested in, questions of property in scientific knowledge; he wanted to see the truth grow, and was prepared to welcome contributions from any source to its enlargement.

Rutherford used to tell me that, though he held his Cavendish Chair under statutes which imposed no age limit, he intended to retain it till he was 70, and then to make way for a younger man. Certainly he showed no sign of any abatement of his mental energy or his tremendous physical vigour, right up to his death, after a short illness due to a surgical accident, at the age of 66. "I want to leave £100 to Nelson College", were almost his last words to his wife. A whole world was in mourning for him, and testimonies came from all directions, to the simple grandeur of his personal character, as well as to his scientific triumphs. "Rutherford never made an enemy or lost a friend", said one who had known him long and intimately. "I never thought of Rutherford as a clever man", said Niels Bohr to me a few years ago; "he was much more than that—one of the few really great men". Several compared his epoch-making achievement in science to that of Newton—"Rutherford was the Newton of the atom", said more than one; and in 1939, when German scientists, under the Nazi rule and with the shadow of war advancing, had to be careful of their words, I heard his pupil Otto Hahn, speaking in London, say that "German

scientists think of Ernest Rutherford as probably the greatest figure in science that the world has produced since Isac Newton". Rutherford was lost to us at a time when we and all the world most surely needed the strength of his wisdom and the guiding power of his genius. The world was nearer then than any had believed, to the practical realization of further discoveries in Rutherford's nuclear physics—discoveries which were to make it possible for human agency to initiate the fission of atomic nuclei as a chain reaction, and thus to release the enormous energy known to be bound in their structure, but regarded, till then, as possibly for ever inaccessible to man. The world is now faced with the problem of ensuring the use of this gigantic new source of power, only for enlarging the material opportunities of human well-being and happiness, and of preventing its further use for destruction—for the destruction, perhaps, of all that civilization has painfully been building since before the dawn of history. And such a world may well feel orphaned by the loss from its councils, before his due time, of this great son of New Zealand, whose life and achievements had placed him among the few great ones, in all the long history of man's effort to understand the material universe in which he has his being.